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TITLE: SDA Volatile Organic Data Compilation: Soil Vapor Emission, and Water Samples

SUMMARY:

This report is a compilation and summary of volatile organic compound (VOC) concentration measurements in soil vapor, perched water, and groundwater samples collected in the vicinity of the SDA. A summary of only the most prevalent VOCs, namely: carbon tetrachloride, chloroform, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethane is presented herein. The data presented is this report is divided into three sections: (a) soil vapor data (Section 2), (b) soil vapor emission data (section 3), and (c) water quality data (section 4).

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SDA Volatile Organic Data Compilation: Soil Vapor, Soil Vapor Emission, and Water Samples

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1.0 INTRODUCTION

This report is a compilation and summary of volatile organic compound (VOC) concentration measurements in soil vapor, perched water, and groundwater samples collected in the vicinity of the SDA. Since VOCs were discovered in groundwater near the SDA in 1987, there have been numerous sampling efforts to determine the nature and extent of the VOC contamination. VOCs have been measured in soil vapor samples collected from shallow holes made with probes, open wells with packed off intervals and wells with permanent vapor sampling ports throughout the entire vadose zone. VOCs have been measured in soil vapor emissions collected with flux chambers. VOCs have also been measured in perched water samples inside SDA boundaries and in groundwater samples from wells around the SDA.

This report contains only the data for the most prevalent VOCs, namely: carbon tetrachloride, chloroform, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene. These compounds comprise the majority of the VOC inventory disposed in the SDA. In some cases however, 1,1,1-trichloroethane and tetrachloroethene were sometimes not included in a particular reference because their concentrations were much less than the other three compounds. Although the data contained in this report are extensive, no claims are made as to the completeness of the data. Given the large amount of data and data sources, some data was probably not discovered by the search. However, the amount of data that may be missing is believed to be small. In addition, the data presented here are believed to be the most accurate, representative and most useful for future modeling efforts. Some VOC data was not included here because of it's questionable usefulness, uncertainty regarding its accuracy, and the high cost of retrieving and verifying it. This is discussed later in the report.

The report is divided in soil vapor data (Section 2), soil vapor emission data (Section 3) and water quality data (Section 4). Where possible, data in this report was retrieved in electronic form and put into tables. However, much of the data and information for this report was photocopied from other sources. Due to the amount of photocopied material, tables and figures have been put in Appendices A and B respectively.

2.0 SOIL VAPOR DATA

This section contains soil vapor data which includes analyses of gas samples taken below land surface but above the water table. Soil vapor samples have been collected from a number of different locations using different methods. Soil vapor analyses have been done by a combination of portable gas chromatograph (GC) and laboratory methods. A description of the sampling method and analysis for GCs is discussed in Lodman et al. (1994).

Most of the data and the most accurate soil vapor VOC data have been collected since 1991. Evaluation of soil vapor measurements prior to 1991 using field GCs revealed high variability, many outlier data points and data of questionable reliability (Izbicki 1992a). The non-linear response of the GC, a response unknown at the time to the GC operators is believed to have biased concentrations high. The relatively high concentrations of vapors encountered at the SDA was not suitable for gas chromatographic analysis where low concentrations and associated instrument sensitivity is the standard. Izbicki (1992a) recommends soil vapor data prior to 1991 be used only for identification of contaminants and qualitative analysis.

Since 1990, data quality objectives and associated quality assurance requirements for soil vapor monitoring using the portable GC have been better defined. Dilution procedures have solved the problem of analyzing high concentrations. In fact, much of the field GC data in this report have been method validated to quality level C using confirmatory analysis at Argonne National Laboratory East (ANL-E) and the Environmental Control Unit (ECU) laboratory at the INEL. In some sources the ECU lab is referred to as ECL.

2.1 Shallow Soil Vapor Survey Data

Two shallow vapor surveys (SVSs) have been conducted at the SDA. The first SVS, conducted in 1987 by Golder and Associates, covered all of the SDA and 600 feet outside the SDA boundary. Soil vapor samples were collected at a depth of 30 inches below land surface on a regular grid with some additional locations in areas of interest. The sampling locations are shown in Figure 1. Analysis was performed for 12 VOCs in a field laboratory set up in a trailer immediately north of the SDA using an HNU Model 321 field GC. The results for carbon tetrachloride, chloroform and trichloroethene are contained in Table 1. In addition to shallow vapor samples, several samples from greater depths were also analyzed. The deeper vapor samples came from neutron access tubes, pit access tubes and permanent vapor sampling ports in wells 77-1, 78-4 and WWW-1. The source of the data is Laney et al. (1988).

The second SVS was performed in January and February of 1992 by the Environmental Technology Unit of EG&G Idaho Inc. The shallow soil vapor sample locations were an identical subset of the locations sampled by Golder and Associates in 1987 as shown in Figure 1. In addition to shallow vapor samples, shallow wells (< 20 feet) were sampled. The locations of the shallow vapor sampling locations and the shallow wells sampling locations are shown in Figure 2 and Figure 3 respectively. Results of the shallow SVS and the shallow well sampling for carbon tetrachloride, chloroform and trichloroethene are shown in Table 2 and Table 3. QA sample results are shown in Table 4. The source of the data is Anderson (1992).

2.2 Soil Vapor Data from Wells

This section contains soil vapor data from 1991 through January 1995. Soil vapor data presented in this section is the result of samples taken in wells with permanent vapor sampling ports or open wells using a dual packer system to isolate a particular interval. Most of the samples were taken at depths of 20 to approximately 600 ft. Three wells (TEM1-A, TEM2-A, and TEM3-A) have permanent sampling ports less than 20 ft deep. Open wells sampled include 92, 9901-T, DO6A, 79-2, 76-5, and 8901. Well 8901 is the original VVE well and is open from 90 ft below land surface to approximately 200 ft since the well screen was pulled in 1993. Wells with permanent vapor sampling ports include 77-1, 78-4, WWW-1, 8801, 8902, DO2, 118, M1S, VVE1, M3S, VVE3, M4D, VVE4, M6S, VVE6, M7S, VVE7, M10S, VVE10, 9301, 9302, TEM1-A, TEM2-A, TEM3-A, 1E, 2E, 3E, 4E, 5E, 1V, 2V, 3V, 4V, 5V, 6V, 7V, 8V, 9V, and 10V. The locations of most of these wells are shown in Figure 4. These wells have been constructed with screened sampling ports connected to land surface by stainless steel tubing.

Excluding the deep soil vapor measurements performed by Golder and Associates during the 1987 SVS, the first soil vapor samples were collected at the SDA in 1989. Soil vapor data from 1989 and 1990 are not presented here because of the questionable validity of GC results discussed previously and confusion over the ports/depths that were sampled. Some of this data can be found in Harris (1990), and Sisson and Ellis (1990). In addition, VOC data from 1989 and 1990 were collected primarily to determine the effectiveness of the vapor vacuum extraction (VVE) system which operated for two weeks in November, 1989 and for approximately four months from April to August in 1990. Soil vapor data collected during the Organic Contamination in the Vadose Zone (OCVZ) Treatability Study (TS) in 1993 when the VVE system ran for approximately five months would be much better for determining the response of the VOC plume to vapor extraction.

VOC soil vapor data are presented chronologically in the calendar year it was collected and then broken down further by project or sampling event as necessary. Some data are presented outside of year it was collected in if the project or group of samples overlapped into another year.

1991 Soil Vapor Data

All the VOC data for 1991 were downloaded from the ERIS database and is contained in Table 5. Soil vapor samples were collected from wells 77-1, 78-4, WWW-1, 8801, 8902, and DO2. These samples were analyzed by the ANL-E laboratory using a modified EPA method TO-14. A subset of the data was analyzed using portable GCs at the INEL for comparison to the ANL-E analyses. The results of the comparison and the GC analyses are contained in Izbicki (1992a). In general, the ANL-E results and the GC results compared well. The greatest discrepancy occurred when the ANL-E laboratory had to dilute samples 50 times or more to stay within the calibration of the instrument.

1992 Soil Vapor Data

A great deal more soil vapor data were collected in 1992 as part of the OCVZ Remedial Investigation and Feasibility Study (RI/FS). As part of the OCVZ RI/FS, twelve new vapor monitoring wells were constructed outside the SDA boundary. The wells were constructed in pairs so that a deep well that served as combination groundwater and vapor monitoring well was in close proximity to a shallow vapor monitoring well. The deep wells are designated M1S, M3S, M4D, M6S, M7S, and M10S and have 3 to 4 permanent vapor sampling ports installed at depths between the 240 ft interbed and the water table. The companion wells designated VVE1, VVE3, VVE4, VVE6, VVE7, and VVE10 have 3 to 4 vapor sampling ports installed between the ground surface and the 240 ft interbed. In addition, three shallow wells were installed in the surficial sediments. The wells are designated TEM1-A, TEM2-A, and TEM3-A and contain vapor sampling ports every two ft from ground surface down to depths of 10 to 18 ft.

VOC data for 1992 are contained in Tables 6, 7, 8, 9, and 10. Data in Table 6 comes from Izbicki (1992b) and contains sampling data from December 1991 to January 1992 and from July to September 1992 for wells 8801, 8902, D02, 77-1, 78-4, and WWW-1.

Some of the ports from the new M and VVE series wells were sampled during the July to September time frame and were sent to the ECU laboratory for confirmatory analysis along with some samples from the older wells. These data contained in Table 7, comes from the OCVZ RI report (Duncan et al. 1993).

Table 8 contains carbon tetrachloride concentration data from August 1992 to November 1992. These data were also taken from Duncan et al. (1993). Except for the September samples, these data are not validated. Data for species other than carbon tetrachloride could not be located in time to be included in this report. It should be noted that the VOC data from the M and VVE series wells in Tables 7 and 8 may not be representative because of possible dilution of subsurface vapors by the air used during drilling.

VOC data from wells TEM1-A, TEM2-A and TEM3-A, sampled on August 18 and 19, are contained in Table 9. This is believed to be the only sampling done on these wells except for sampling during the OCVZ Treatability Study (TS). The source of this data is Hubbell (1992).

The last set of 1992 VOC vapor data is contained in Table 10. This data was collected at well 8902 between August 26 and September 2 as part of an experiment to determine the effects of barometric fluctuations on subsurface vapor concentrations. The source of this data is Weidner et al. (1992).

1993 Soil Vapor Data

Most of the VOC soil vapor data was collected during 1993. In 1993, the TS was conducted and a Mobile Laboratory (ENSECO) was set up near the SDA and analyzed hundreds of samples collected during the TS from April to August 1993.

Prior to the TS, open wells 92, 8801T, DO6A, 79-2 and 76-5 were sampled in December 1992 and January 1993. Packers were used to isolate intervals in the wells and vapor samples were collected every 10 or 15 feet. This data is contained in Table 11 and was taken from Duncan et al. (1993).

In March 1993, also prior to the TS, a number of wells were sampled probably to provide a baseline on which to evaluate VVE performance. These data are shown in Table 12 only for carbon tetrachloride. The data was taken from Duncan et al. 1993 which states only the carbon tetrachloride data was "the most complete."

The bulk of the 1993 data is the ENSECO data from the OCVZ TS. These data are contained in Table 13 and were downloaded from the ERIS database. Additional information about these data including plots and trends can be found in the OCVZ TS report (Lodman et al. 1994).

1994 to Present Soil Vapor Data

Since November 1993, a routine soil vapor and groundwater monitoring program has been conducted by Waste Area Group 7 (WAG-7). This monitoring consists of quarterly sampling of specific vapor ports inside and outside the SDA. Samples are analyzed for carbon tetrachloride, chloroform, and trichloroethene using a portable GC. After June 1994, samples from wells outside the SDA have been analyzed for total chlorinated organic vapor concentrations using a portable vapor monitor. Samples from ports with high and low concentrations are sent to the ECU lab for confirmatory analysis and validated to quality level "C".

Table 14 contains the carbon tetrachloride, chloroform, and trichloroethene data from November 1993 to January 1995 for wells inside the SDA. Table 15 contains the carbon tetrachloride, chloroform, and trichloroethene data from November 1993 to June 1994 for wells outside the SDA. Total chlorinated organic data from wells outside the SDA, beginning in November 1994, are contained in Table 16. The source of these data is Barrie (1995).

Samples sent to ECU for confirmatory analysis are contained in Table 17. These data were downloaded from the ERIS database. Samples sent to the ECU lab are analyzed for several species of chlorinated organics. When the concentrations of carbon tetrachloride, chloroform, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene are summed, the result compares very well with the total chlorinated organic analyses using the portable vapor monitor.

3.0 SOIL VAPOR EMISSION DATA

Soil vapor emission (flux) data were collected in December 1992 and again in July 1993 at the same locations at the SDA. The purpose of sampling at two different times was to determine seasonal effects on flux rates. Sample locations are shown in Figure 5. December 1992 (winter) results are shown in Table 18 and July 1993 (summer) results are shown in Table 19. A summary of the results comparing winter and summer data is contained in Table 20. At one of the locations during July 1993, several samples were taken to determine the effect of barometric pressure fluctuations on flux rates. These data are contained in Table 21. The sources of these data are Schmidt (1994a) and Schmidt (1994b).

4.0 VOC WATER QUALITY DATA

4.1 Perched Water Data

VOC data for perched water at the SDA is limited due to the limited amount of perched water and the small number of perched water sample locations. Organic compounds have been detected in three perched water wells (92, 8802D, and D10) located inside the SDA. The perched water in wells 92 and 8802D has been sampled 5 and 2 times, respectively. The perched water in Well D10 has been sampled only once since construction. 19 VOCs have been detected in Wells 92 and 8802D and 17 VOCs have been detected in Well D10 (Hubbell, 1990 and 1993). Only carbon tetrachloride, chloroform, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene results are reported here. The VOC concentrations for each well and sampling date are contained in Table 22.

4.2 Groundwater Data

The United States Geologic Survey (USGS) began reconnaissance level sampling for purgeable organic compounds in groundwater at the Idaho National Engineering Laboratory (INEL) in June, 1987. Since 1987, groundwater samples are collected regularly from INEL wells that tap the aquifer and are analyzed for 26 organic compounds. The USGS's VOC sampling results from 1987 through 1991 are documented in Mann and Knobel (1987), Mann (1990), and Liszewski and Mann (1992). Since 1991, the results have not been published in a report, but are kept on file in the USGS office at the INEL. These data were not available to be printed in this report, but will be included in the compilation once they are obtained.

Data is reported here only for wells sampled by the USGS in the vicinity of the SDA. These wells are 86, 87, 88, 89, 90, 117, 119, 120, and the RWMC production well. Results for carbon tetrachloride, chloroform, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene are presented in Table 23.

In addition to USGS sampling, the groundwater near the SDA has been routinely sampled by WAG-7 personnel since October 1992 and analyzed for metals, VOCs and radioactivity. VOC data from the WAG-7 sampling program were downloaded from the ERIS database. The wells sampled are M1S, M3S, M4D, M6S, M7S, and M10S. The data are contained in Table 24. Graphical results of the ERIS groundwater VOC data can be found in Barrie (1995).

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